

## Claims

28. A method of radiotherapy of a malignant neoplasm using X-ray beams and consisting of two stages: the first stage consists in imaging of the internal structure of the patient's part (5) comprising a malignant neoplasm, together with the organs and tissues, surrounding it, on the basis of data represented as a set of spatial coordinates of the points, to which the current measurement results of measuring are attributed, and patient biological tissues' density values corresponding to the said coordinates,
- thereupon, using the previous diagnostics results, the images of the structural elements relating to the malignant neoplasm are identified;
- then, an exposure program is made as a set of X-ray dosages to be delivered to different parts of the malignant neoplasm, represented by fixed sets of the point coordinates,
- then, the second stage begins, when the formed exposure program is carried out,
- wherein during the first stage, in order to obtain the said data about the patient's internal structure, X-rays are concentrated in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm;
- secondary radiation excited in the said zone and having a  $4\pi$  steradian angle of scattering is transported to one or more detectors (6, 20), excluding, in this instance, the possibility that x-ray radiation of the sources used would get onto the inputs of detectors directly or after it has passed through the patient,
- the patient's part comprising the malignant neoplasm is scanned, for which purpose the radiation concentration zone and the patient are moved relatively to each other,
- and based on the secondary radiation intensity values obtained by means of one or more detectors and defined concurrently with coordinates of the point in the x-rays concentration zone, to which point the current measurement re-



sults are attributed, judgment is made regarding the density of the biological tissues in the said point,

the quantitative indices, taken as the density values of the biological tissues, together with the values of coordinates corresponding to the said indices, are used for imaging distribution of the biological tissues densities within the patient's part containing the malignant neoplasm,

while during the second stage, the volume occupied by the malignant neoplasm is scanned, at the same time concentrating X-rays using the same means as during the first stage, so that the positions, occupied by the concentration zone (16) would correspond to the parts of the malignant neoplasm, represented by the sets of the points coordinates, fixed during the first stage as a result of identification of images of the structural elements, related to the malignant neoplasm;

and the exposure program made during the first stage is carried out through increase of the x-rays intensity as compared to the first stage, and exposure time regulation.

29. A method according to claim 28,

wherein a X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of collimators (13, 18), using a respective number spaced X-ray sources (1, 17),

while transportation of excited secondary radiation to one or more detectors is done by means of one or more collimators (15, 19);

in this instance all collimators are oriented so that the axes of their central channels would cross in the point, to which the current measurement results are attributed.

30. A method according to claim 28,

wherein X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of X-ray hemi



lenses (21) transforming divergent radiation from a respective number of spaced X-ray sources (1) into quasi-parallel,

while transportation of excited secondary radiation to one or more detectors is done by means of one or more X-ray hemi lenses (22, 23) focusing this radiation onto the detectors (6, 20), or forming quasi-parallel radiation;

in this instance, all X-ray hemi lenses are oriented so that their optical axes would cross in the point, to which the current measurement results are attributed.

31. A method according to claim 28,

wherein a X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of X-ray hemi lenses (21) transforming divergent radiation from a respective number of spaced X-ray sources (1) into a quasi-parallel,

while transportation of the excited secondary radiation to one or more detectors is done by means of one or more X-ray lenses (3) focusing this radiation onto the detectors (6);

in this instance, all X-ray hemi lenses and lenses are oriented so that their optical axes would cross in the point, to which the current measurement results are attributed.

32. A method according to claim 28,

wherein X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of several X-ray hemi lenses (21) transforming divergent radiation from a respective number of spaced sources into quasi-parallel,

while transportation of excited secondary radiation to one or more detectors is done by means of one or more collimators (19, 15);

in this instance, all X-ray hemi lenses and collimators are oriented so that the optical axes of all X-ray hemi lenses and the central channels of all collima-



tors would cross in the point, to which the current measurement results are attributed.

33. A method according to claim 28,

wherein X-rays concentration in the zone (4) including the point, to which  
5 the current measurement results are attributed and located inside the patient's  
part comprising the malignant neoplasm, is done by means of one or more  
spaced X-ray sources (1) and a respective number of X-ray lenses (3) focusing  
divergent X-rays from each source into the point, to which the current meas-  
urement results are attributed;

10 while transportation of excited secondary radiation to one or more detec-  
tors (6) is done by means of X-ray lenses (3) focusing this radiation onto the  
detectors and having the second focus in the said point.

34. A method according to claim 28,

wherein X-rays concentration in the zone (16) including the point, to  
15 which the current measurement results are attributed and located inside the pa-  
tient's part containing the malignant neoplasm, is done by means of one or  
more spaced X-ray sources (1) and a respective number of X-ray lenses (2) fo-  
cusing divergent X-rays of each source into the point, to which the current  
measurement results are attributed,

20 while transportation of excited secondary radiation to one or more detec-  
tors (6, 20) is done by means of the collimators (15, 19), oriented so that the  
optical axes of their central channels would cross in the said point.

35. A method of determining the location of a malignant neoplasm using  
X-ray beams, where imaging of the internal structure of the patient's part con-  
25 taining the malignant neoplasm together with the organs and tissues, surround-  
ing the said neoplasm, is done on the basis of the information represented as a  
set of spatial coordinates of the points, to which the current measurement re-  
sults are attributed, with the density values of the biological tissues, which val-  
ues correspond to those coordinates,



thereupon, using the previous diagnostics results, the images of the structural elements, related to the malignant neoplasm, are identified,

wherein, in order to obtain the said information about the internal structure of the patient's part, X-rays are concentrated in the zone including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm,

secondary radiation excited in the said zone and having a  $4\pi$  steradian angle of scattering is transported to one or more detectors, excluding, in this instance, the possibility that x-ray radiation of the sources used would get onto the inputs of detectors directly or after it has passed through the patient,

the patient's part containing the malignant neoplasm, is scanned, for which purpose the radiation concentration zone and the patient are moved relatively to each other,

and on the basis of the set of intensity values of the secondary radiation, obtained using one or more detectors and defined concurrently with coordinates of the point in the radiation concentration zone, to which point the current measurement results are attributed, judgment is made regarding density of the biological tissues in the said point,

the quantitative indices, taken as the density values of biological tissues, together with the values of coordinates, corresponding to the said quantitative indices, are used for imaging the distribution of the biological tissues densities in the patient's part containing the malignant neoplasm,

then the combinations of coordinates of the points and corresponding thereto biological tissues densities identified as related to the malignant neoplasm, are fixed.

36. A method according to claim 35,

wherein X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part (5), containing the malignant neoplasm, is done by means of collimators (13, 18), using a respective number of spaced X-ray sources (1, 17),



and transportation of excited secondary radiation to one or more detectors is done by means of one or more collimators (15, 19),

in this instance, all collimators are oriented so that the axes of their central channels would cross in the point, to which the current measurement results are attributed.

37. A method according to claim 35,

wherein X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of X-ray hemi lenses (21) transforming divergent radiation from a respective number of spaced X-ray sources into quasi-parallel,

and transportation of excited secondary radiation to one or more detectors is done also by means of one or more X-ray hemi lenses (22) focusing this radiation onto the detectors (6, 20) or forming quasi-parallel radiation;

in this instance all X-ray hemi lenses are oriented so that their optical axes would cross in the point, to which the current measurement results are attributed.

38. A method according to claim 35,

wherein X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part (5) containing the malignant neoplasm, is done by means of X-ray hemi lenses (21), transforming divergent radiation from a respective number of spaced X-ray sources (1) into quasi-parallel,

while transportation of excited secondary radiation to one or more detectors (6) is done by means of one or more X-ray lenses (22) focusing this radiation onto the detectors;

in this instance all X-ray hemi lenses and lenses are oriented so that their optical axes would cross in the point, to which the current measurement results are attributed.



39. A method according to claim 35,

wherein X-rays concentration in the zone (16) including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of several X-ray hemi lenses (21) transforming divergent radiation from a respective number of spaced sources (1) into quasi-parallel,

while transportation of excited secondary radiation to one or more detectors (6, 20) is done by means of one or more collimators (15, 19);

in this instance, the X-ray hemi lenses and collimators are oriented so that the optical axes of all X-ray hemi lenses and the central channels of all collimators would cross in the point, to which the current measurement results are attributed.

40. A method according to claim 35,

wherein X-rays concentration in the zone including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of one or more spaced X-ray sources (1) and a respective number of X-ray lenses (2) focusing divergent X-rays from each source into the point (4), to which the current measurement results are attributed,

while transportation of excited secondary radiation to one or more detectors (6) is done by means of the X-ray lenses (3) focusing this radiation onto the detectors and having the second focus in the said point.

41. A method according to claim 35,

wherein X-rays concentration in the zone including the point, to which the current measurement results are attributed and located inside the patient's part containing the malignant neoplasm, is done by means of one or more spaced X-ray sources (1) and a respective number of X-ray lenses (2) focusing divergent radiation of each source onto the point, to which the current measurement results are attributed,



while transportation of excited secondary radiation to one or more detectors (6, 20) is done by means of the collimators (15, 19), oriented so that the optical axes of their central channels would cross in the said point.

42. A device for determining the location of a malignant neoplasm and its radiotherapy using X-ray beams, comprising an X-ray optical system (8), a device (10) for relative positioning of the patient and the X-ray optical system, a device (12) for data processing and imaging, which is made so as to provide the possibility of imaging and displaying the distribution of the tissues densities for the patient's part (5), containing the malignant; in this instance the X-ray optical system (8) includes one or more X-ray sources (1) with the devices (2) for their radiation concentration, and one or more detectors (6), which outputs are connected up to the device (12) for data processing and imaging,

wherein the X-ray sources, being a part of the X-ray optical system (8), are made capable of changing the intensity of their radiation,

and the X-ray optical system comprises a means (9) of shared control of the radiation intensities of X-ray sources (1),

while the means (2) for concentrating the radiation of these sources are made capable and placed so as to ensure concentration of radiation from all sources in the zone including the point, to which the current measurement results are attributed and located inside the patient's part (5) containing the malignant neoplasm;

the X-ray optical system (8) also comprises one or more means (3) for transportation of the secondary radiation excited in the concentration zone and having a  $4\pi$  steradian angle of scattering to the detectors (6), placed at the outputs of the said means and made sensitive to the said secondary radiation, in this instance, the detectors and the means for transportation of the secondary radiation thereto are placed so that they are never positioned in the extension of the optical axes of any of the source x-rays concentration means;

to the means (10) for relative positioning of the patient and x-ray optical systems, used for scanning by the source x-rays concentration zone of the pa-



tient's part (5), containing a malignant, sensors (11) are connected for determining coordinates of the point, to which the current measurement results are attributed and which is located inside the patient's part (5) containing the malignant neoplasm, the outputs of which sensors being connected to the means  
 5 (12) for data processing and imaging.

43. A device according to claim 42,  
 wherein an X-ray optical system comprises several X-ray sources (1, 17),  
 each of the means concentrating the radiation of the said sources in the  
 zone (16) including the point, to which the current measurement results are at-  
 10 tributed, and each of the means transporting secondary radiation excited in the  
 said zone to the detectors (6, 20), are made as the collimators (13, 15, 18, 19)  
 with their channels oriented to the zone of concentrated radiation from the X-  
 ray sources,

in this instance, the optical axes of the central channels of all collimators  
 15 cross in the point, to which the current measurement results are attributed.

44. A device according to claim 43,  
 wherein the X-ray sources (1), being a part of the X-ray optical system,  
 are quasi-point,  
 and the collimators (13) have their channels focused on the said sources,  
 20 and there is a screen (14) with a hole, which is placed between the output  
 of each X-ray source and the input of corresponding collimator.

45. A device according to claim 43,  
 wherein the X-ray sources (17), being a part of the X-ray optical system,  
 are extended,  
 25 and the collimators (18) have their channels widening towards the X-ray  
 sources.

46. A device according to claim 42,  
 wherein the X-ray sources (1), being a part of the X-ray optical system,  
 are quasi-point,



each of the means concentrating x-rays in the zone including the point, to which current measurement results are attributed, is made as an X-ray hemlines (21), which transforms divergent radiation of the corresponding source into a quasi-parallel one,

5 while each of the means transporting excited secondary radiation to the detector is made as an X-ray hemlines (22), focusing this radiation onto the detector (6),

in this instance, the optical axes of all X-ray hemi lenses cross in the point, to which the current measurement results are attributed.

10 47. A device according to claim 42,

wherein the X-ray sources (1), being a part of the X-ray optical system, are quasi-point,

each of the means concentrating x-rays in the zone including the point, to which the current measurement results are attributed, is made as an X-ray hem-  
15 lines (21), which transforms divergent radiation of the corresponding source into quasi-parallel,

while each of the means transporting excited secondary radiation to the detector (20) is made as an X-ray hemlines (23), forming quasi-parallel radiation and having its focus in the x-rays concentration zone (16),

20 in this instance, the optical axes of all X-ray hemi lenses cross in the point, to which the current measurement results are attributed.

48. A device according to claim 42,

wherein the X-ray sources (1), being a part of the X-ray optical system, are quasi-point,

25 each of the means concentrating x-rays in the zone (16) including the point, to which the current measurement results are attributed, is made as an X-ray hemlines (21), which transforms divergent radiation of the corresponding source into quasi-parallel,



while each of the means transporting excited secondary radiation to the detector (20) is made as an X-ray lens (3), focusing this radiation onto the detector (6) and having its second focus in the x-rays concentration zone,

the optical axes of all X-ray hemi lenses and lenses cross in the point, to  
5 which the current measurement results are attributed.

49. A device according to claim 42,

wherein the X-ray sources (1), being a part of the X-ray optical system, are quasi-point,

each of the means concentrating x-rays in the zone including the point, to  
10 which the current measurement results are attributed, is made as an X-ray hem-  
lines (21), which transforms divergent radiation of a corresponding source into  
quasi-parallel,

while each of the means transporting excited secondary radiation to the detector is made as a collimator (19) with its channels diverging towards the  
15 corresponding detector (20),

the optical axes of all X-ray lenses and hemi lenses and the central channels of the collimators cross in the point, to which the current measurement results are attributed.

50. A device according to claim 42,

20 wherein the X-ray sources (1), being a part of the X-ray optical system, are quasi-point,

each of the means concentrating x-rays in the zone (16) including the point, to which the current measurement results are attributed, is made as an X-ray hemlines (21), which transforms divergent radiation of the corresponding  
25 X-ray source into quasi-parallel,

while each of the means transporting excited secondary radiation to the detector is made as a collimator (15) with its channels converging towards the corresponding detector (6),



the optical axes of all X-ray hemi lenses and the central channels of the collimators cross in the point, to which the current measurement results are attributed.

51. A device according to claim 42,

5 wherein the X-ray sources (1), being a part of the X-ray optical system, are quasi-point,

each of the means concentrating x-rays in the zone including the point, to which the current measurement results are attributed, is made as an X-ray lens (2), which focuses divergent radiation of an X-ray source,

10 each of the means transporting excited secondary radiation to the detector is made as an X-ray lens (3), which focuses this radiation onto the corresponding detector (6),

the optical axes of all X-ray lenses cross in the point (4), to which the current measurement results are attributed.

15 52. A device according to claim 42,

wherein the X-ray sources (1) being a part of the X-ray optical system are quasi-point,

each of the means concentrating x-rays in the zone including the point, to which the current measurement results are attributed, is made as an X-ray lens  
20 (2), which focuses divergent radiation of an X-ray source,

each of the means transporting excited secondary radiation to the detector is made as a collimator (15) with its channels converging towards the corresponding detector (6),

25 the optical axes of all X-ray lenses and the central channels of the collimators cross in the point, to which the current measurement results are attributed.

53. A device according to claim 42,

wherein the X-ray sources (1) being a part of the X-ray optical system are quasi-point,



each of the means concentrating x-rays in the zone (16) including the point, to which the current measurement results are attributed, is made as an X-ray lens (2), which focuses divergent radiation of an X-ray source,

each of the means transporting excited secondary radiation to the detector  
5 is made as a collimator (19) with its channels diverging towards the corresponding detector (20),

the optical axes of all X-ray lenses and the central channels of the collimators cross in the point, to which the current measurement results of measuring are attributed.

10 54. A device according to any one of claims 42-53,

wherein the said device comprises additionally the means for switching off or screening the detectors for the time of the X-ray sources' operation with an increased intensity.